ARM Automation, Inc.

Modular Manipulator for Robotics Applications

Technology Need:

Across the Department of Energy (DOE) Complex, numerous hazardous material handling operations are performed within the confines of a glovebox. Typically, glovebox operations are performed manually through lead-lined gloves. The DOE continues to seek safer and more efficient means of handling these materials inside gloveboxes. Automation of glovebox operations using robotic technology reduces human exposure to radiation and increases process efficiency.

Incorporating automation machinery into a glovebox environment is challenging. The robotic device must be designed to operate in existing gloveboxes. Maintenance issues and failure scenarios must be considered. For example, repair or maintenance must be accomplished inside the glovebox. Broken equipment, now contaminated, must be removable through a glove port for disposal. The automation machinery must also be compatible with the materials to be handled within the glovebox, such as plutonium.
Existing robotic technology has several drawbacks, including low payload to weight ratios, cumbersome wiring, and proprietary system controls. Customized systems based on existing technology are expensive to develop, integrate, and maintain.

This project focuses on the needs of Automated Plutonium Processing (APP) tasks which involve the manipulation of plutonium containers and the transfer of their contents inside of a glovebox.

Technology Description:

ARM automation has developed a modular actuator that is used as a building block for custom robotic-manipulator systems. These modular manipulator systems are well suited to the challenges associated with automation of glove box operations. For this project, modular actuators were configured into a robotic system capable of plutonium repackaging operations, a typical glovebox operation in APP. This manipulator system is pictured in Figure 1. The modular approach to automation utilizes a small set of versatile actuator modules to construct a broad range of robotic systems suited to EM applications. The modular components of the system utilize quick connects that simplify installations into "hot" boxes and any potential modifications or repair therein.

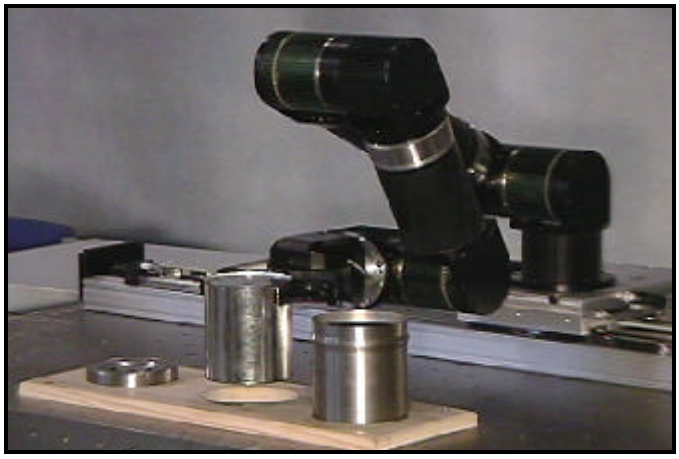

Figure 1: Modular Manipulator System for Automated Plutonium Processing.

The term "actuator module" refers to a component of a robotic system that consists of a tightly integrated package containing an electric motor, gear train, output support bearings, position sensors, brake, servo-amplifier, and communications control. In the field of automation and robotics, an actuator is a common element used to generate motion for precise positioning of loads. One example of an actuator would be an individual joint within an industrial robotic manipulator.

Each actuator module is based upon a core technology

called the DISC™, which stands for Digital Intelligent Servo Controller. Each DISC™ device is a miniature control and communications node that can be linked with other DISC™ devices to create a distributed control network of motion devices and sensors. DISC™ devices communicate over an industrial communications protocol called SERCOS, which is specifically designed for high-speed communications between motion control devices.

With the addition of low cost links, yokes, an open-architecture PC-based system controller, and unified operational software, this spectrum of actuators can be integrated into a completely functional robotic manipulator system. The use of DISC® technology provides embedded intelligence and the capacity for true "plug-and-play" operation. The open-architecture on which this system is based eliminates proprietary interfaces and communications which serve to limit the capability and flexibility of automation equipment.

For this project two sizes of actuator modules were designed: the ARM20 and ARM32 actuators. The Elements of the ARM20 modular manipulator system are shown in Figure 2 below.

Figure 2: Elements of Modular Manipulator System

Benefits:

<Modular components can be easily configured into customized systems.
<Quick connect system facilitate installation and repair of system in glovebox environment
<Simplified, open-architecture, PC-based system control promotes integration
<System has high payload to weight ratio
<Modular approach results in small umbilical
<Lower life cycle cost than baseline (based on Fanuc LR-Mate 100i robotic system used by LANL for APP).

Status and Accomplishments:

This project concluded in July 2001. All of the manipulator components have been designed, fabricated, and tested. The technology was demonstrated at Arm Automation's facilities in a simulated glovebox environment. Two aspects of the modular system were successfully demonstrated. The first involved demonstrating the usefulness of the quick connects for passing the modules through the glove port of a glove box and then assembling the manipulator. The second task demonstrated the ability of the system to perform a typical procedure involved with the processing of pure Plutonium into a MOX fuel: inserting a convenience can filled with plutonium, into a hermetically sealed stainless steel primary can (see Figure 1). All demonstration activities were video taped. An Innovative Technology Summary Report for this project is under development and should be available in 2002.

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For additional information, please visit ARM's website at:
http://www.armautomation.com